

Technical Memorandum

Lakeview Reservoir (Res 113) Two Zone System

Madison Water Utility

SEH No. MADWU 126154

January 24, 2014



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1. PROJECT OVERVIEW

The Madison Water Utility (MWU) has been working diligently over the past several years to improve their existing infrastructure to maintain a high level of service and reliability to its customers. The MWU consistently provides water quality that surpasses State and Federal standards for health and safety. Numerous planning reports and studies have been completed that evaluate the water system, providing a comprehensive plan that guides the MWU in their efforts to replace aging supply, storage, and conveyance facilities throughout their service area.

The MWU, with the assistance of its consultant, Short Elliot Hendrickson, Inc. (SEH), plans to reconstruct the Lakeview Reservoir (Res 113), a 55,000 gallon elevated steel tank inherited by the MWU during the annexation of the surrounding area to the City of Madison. The reservoir provides water storage and fire protection to a large portion of the Lakeview Hills Neighborhood. The main priorities of the tank reconstruction include the improvement of system static and fire protection pressures within Pressure Zone 5, the addition of storage capacity to serve the north end of the system within Pressure Zone 6E, and replacement of the existing elevated tank, which has come to the end of its useful life.

The primary objectives of this report are summarized as follows:

- Present a detailed analysis of the alternatives under consideration for the Lakeview Reservoir replacement;
- Determine limitations and requirements of the project related to the existing site, public involvement, telecom systems, and permitting;
- Present detailed project costs and available funding options;
- Make recommendations to the MWU regarding selection of the best alternative for final design.

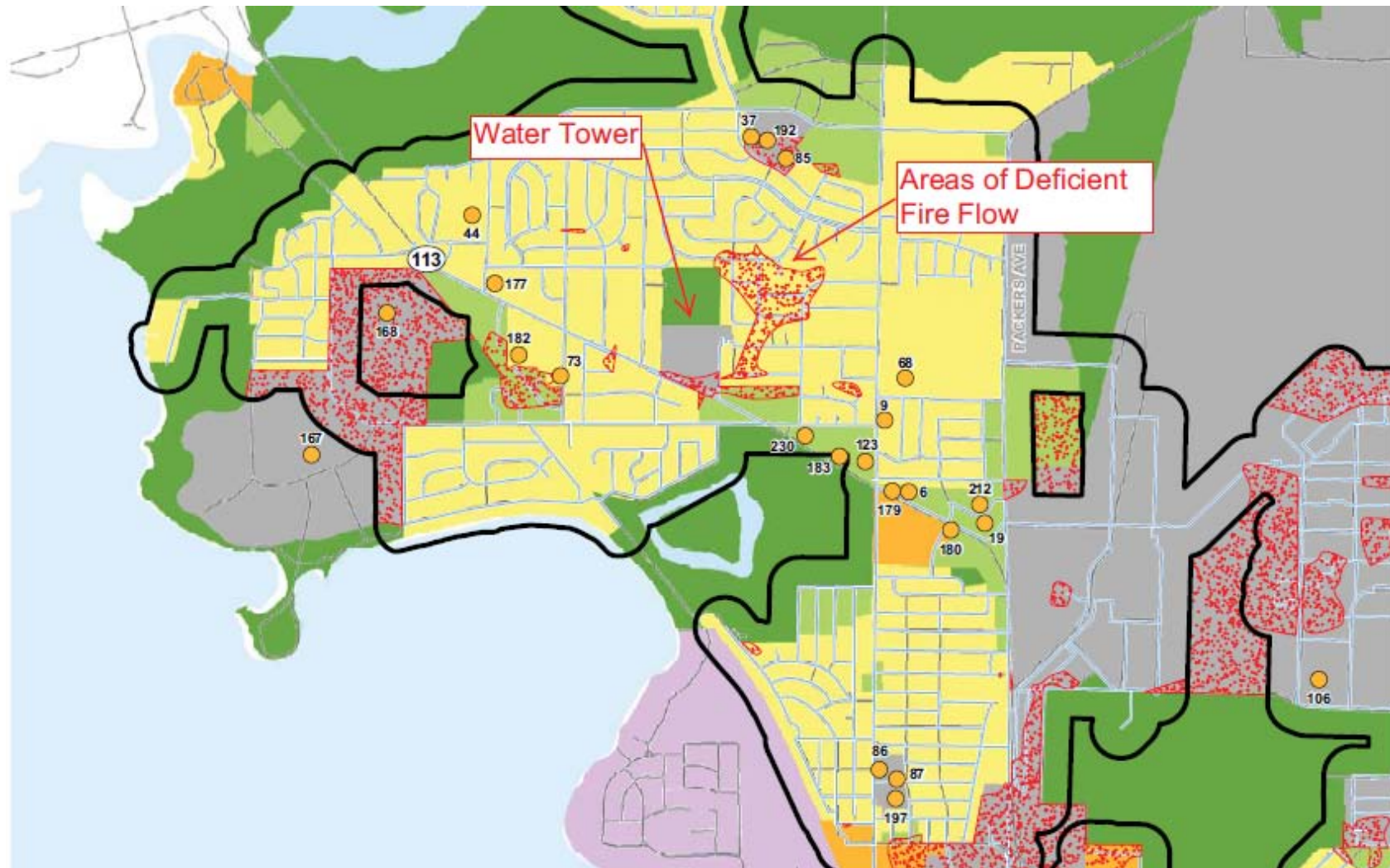
2. BACKGROUND

The existing reservoir is located on land that is leased from Dane County and provides water storage and fire protection to Pressure Zone 5. The tank was constructed in 1938 to supply water to the Lakeview Sanatorium. The tank is located adjacent to Lakeview Park, which is a part of the Dane County park system. In order to mitigate disturbances to the park and surrounding areas, it is desired that the new reservoir be constructed in the same location as the existing reservoir. The existing reservoir has an overflow elevation of 1140 and serves approximately 190 homes and a portion of the Dane County Human Services campus within Zone 5. A map of the existing Lakeview Reservoir location is depicted in Appendix A.

2.1 Correction of System Deficiencies

The 2006 MWU Water Master Plan completed by Black & Veatch determined that Pressure Zone 6E currently has a storage deficiency and insufficient fire flow capacity in the vicinity of Pressure Zone 5 (See Figure 1). Similarly, the same Master Plan identified Zone 5 as currently lacking sufficient fire flow capacity in both the residential and the commercial/institutional areas, mainly due to existing limited reservoir storage volume, the restriction of 6-inch water main in the area and the limited capacity of the nearby Lakeview Booster Station. Available flows of less than 1,000 gallons per minute (gpm) were identified within Zone 5's residential area, and available flows of less than 3,500 gpm have been identified in the area of the Dane County Human Services campus. The deficiency in Zone 6E was validated during the East Side Water Supply evaluation that was completed in 2011/2012, as reported by the MWU. There is a gradient differential of approximately 60 feet between Zones 5 and 6E. In order to

Figure 1
Areas of Deficient Fire Flow



remedy the deficiencies outlined above, storage capacities for Pressure Zones 5 and 6E of 300,000 gallons and 1,000,000 gallons, respectively, have been proposed for the Lakeview Reservoir project. The MWU has identified that the construction of a new, larger reservoir at the site of the existing tank will allow the Utility to address various system needs within a single project.

3. DESIGN CONSIDERATIONS

There are several considerations that must be evaluated prior to and during the design and construction of the Lakeview Reservoir project, including telecom equipment, the existing Lakeview Booster station, public feedback, and the aesthetic appearance of the completed facilities.

3.1 Telecom Equipment

The existing tower sits at a high elevation that has attracted multiple cell phone carriers. The City of Madison has also utilized the site for its own telecommunication equipment. Cell carrier lease revenues are split 50/50 between Dane County and the City of Madison. Dane County utilizes the revenue earned for park care and maintenance. Prior to construction, all telecom systems that are located on the tank, as well as the Sprint equipment located at the base of the tank, are planned to be temporarily relocated for the duration of the tower reconstruction. Existing ground equipment for the cell carrier installations will not be moved, with the exception of the aforementioned Sprint equipment, and care must be taken during construction staging to avoid disturbing the equipment. The new reservoir design will accommodate the cell carrier equipment and City radio system.

3.2 Lakeview Booster Station

The Lakeview Booster Station is located southeast of the Lakeview Reservoir and fills the existing reservoir with water obtained from Pressure Zone 6E. The station was constructed in 1969 and consists of a 300 gpm pump and a 500 gpm pump. Upgrades to the booster station have been budgeted for 2015, following the completion of the Lakeview Reservoir reconstruction project. During the construction of the new reservoir, the booster station will be used to maintain service and emergency protection to Pressure Zone 5. The MWU has stated that a variable speed drive may temporarily be installed at the station to assist with the reconstruction project. The MWU is requesting that, as a part of the alternatives evaluation process, the feasibility and associated costs of utilizing the booster station in combination with the new gravity storage to provide long-term service and emergency supply to Zone 5 are considered.

3.3 Public Involvement

The MWU and SEH are working closely with the public during the preliminary stages of the project design. The MWU has adopted public participation standards and procedures to ensure that the public and neighborhoods affected by Utility projects are made aware of the concept and details and are able to provide feedback. Public meetings will be scheduled throughout the duration of the project, and an open house and public dedication will occur at the completion of construction. The Citizens Advisory Panel (CAP) is involved with this project, and input from the panel will be used in the alternatives evaluation and design of the new reservoir. The CAP will also review and provide feedback for proposals, recommendations, and technical reports for the project. The Water Utility Board considers CAP concerns and advice in the review and approval process for large water projects.

3.4 Aesthetic Appearance

The MWU desires a facility that will compliment the Lakeview Hill neighborhood as much as possible, while maintaining budgetary goals. The Dane County Department of Human Services campus buildings, as well as the telecom equipment buildings, all maintain a matching brick façade exterior. The largest, main office building located south of the reservoir contains unique architectural aspects that could potentially be incorporated into the design of the new reservoir. The ultimate design and aesthetic detail will depend on the construction material(s) of the reservoir, which could be steel, concrete, or a combination of the two. The MWU also requires that the facility be low maintenance and durable.

4. REGULATORY CONSIDERATIONS

Several regulatory entities will be involved throughout the duration of the design and construction of this project, including federal, state, and local regulatory agencies. Timely submission of documentation for permits and approvals is essential to eliminate potential delays to the project timeline, and the early involvement of each agency will mitigate issues and provide insight during design.

4.1 Permitting & Approvals

Due to the nature of the proposed project scope, various permits and approvals will be required. The MWU and SEH will work with the Wisconsin Department of Natural Resources (DNR), the Wisconsin Public Service Commission (PSC), the Federal Aviation Administration (FAA), the Madison Planning and Zoning Departments, and the Board of Public Works throughout the duration of the project planning and construction. Presentations to the City of Madison review agencies and boards, the Common Council, and the public will be performed, as required by the MWU's public participation standards and as required for obtaining the necessary permits and approvals.

4.1.1 Wisconsin Department of Natural Resources (DNR)

DNR approval is required for any improvements, extensions, or alterations which may affect the quality or quantity of water delivered by an existing municipal water system prior to construction. Once the approval request and all required documentation and forms have been received, the DNR may take up to 90 days from receipt to review and approve the project.

4.1.2 Wisconsin Public Service Commission (PSC)

A Certificate of Authority is required from the PSC before construction of many water utility projects, including elevated tanks, reservoirs, and storage facilities. To ensure proper approval is granted and avoid delays, early communication with the PCS is essential. The required paperwork must be submitted to and received by the PSC at least 90 days prior to construction.

4.1.3 Federal Aviation Administration (FAA)

The FAA requires that any notice be given and approval granted for the construction of a structure that is located within the slope area of an adjacent airport. Items mounted on top of the structure, such as antennas and obstruction lights, are included in the height of the structure. The height of the new structure(s), as well as that of the temporary communications monopole, may require FAA involvement and approval.

4.1.4 Madison Planning and Zoning Departments

The project is located in a Conservancy District and has an existing conditional use permit under the City of Madison zoning code. Approval is required for a modification to an existing conditional use permit, which includes gaining Urban Design Commission approval, followed by Plan Commission and Common Council approvals. Public Hearings will be required with each of these approval steps.

4.2 Environmental Considerations

Due to the location and high elevation of the site, there are no surface waters or wetlands on the area that will be affected by construction of the reservoir facility. The DNR offers a web-based Surface Water Data Viewer that depicts rivers, streams, open water, and wetland areas. A map depicting the location of the reservoir site and the surface water data retrieved from the DNR can be seen in Appendix B, which confirms that no known wetlands or surface waters are located near the project site limits.

The land upon which the Lakeview Reservoir is located was developed in the early 1900s as a tuberculosis sanatorium by the City of Madison. In April 1993, several buildings that contributed to the old sanatorium were added to the National Register of Historic Places, including the water utility building and the existing water tower. A follow-up study⁽¹⁾ was performed in 2008 to identify any historical archaeological sites within the parcel, and no evidence of any such sites was discovered. Documented cultural features associated with the use of the property as a former tuberculosis sanatorium can be seen in Figure 2 and include the following:

- Sanatorium building complex
- Fountain
- Wrought iron gateway/arch
- Hog pen foundation
- Cinder pile
- Ice rink earth form
- Concrete waterfall pools
- Concrete and earth form watercourse south of the Nurses' Dormitory
- Rock wall grotto
- Sputum pond depression

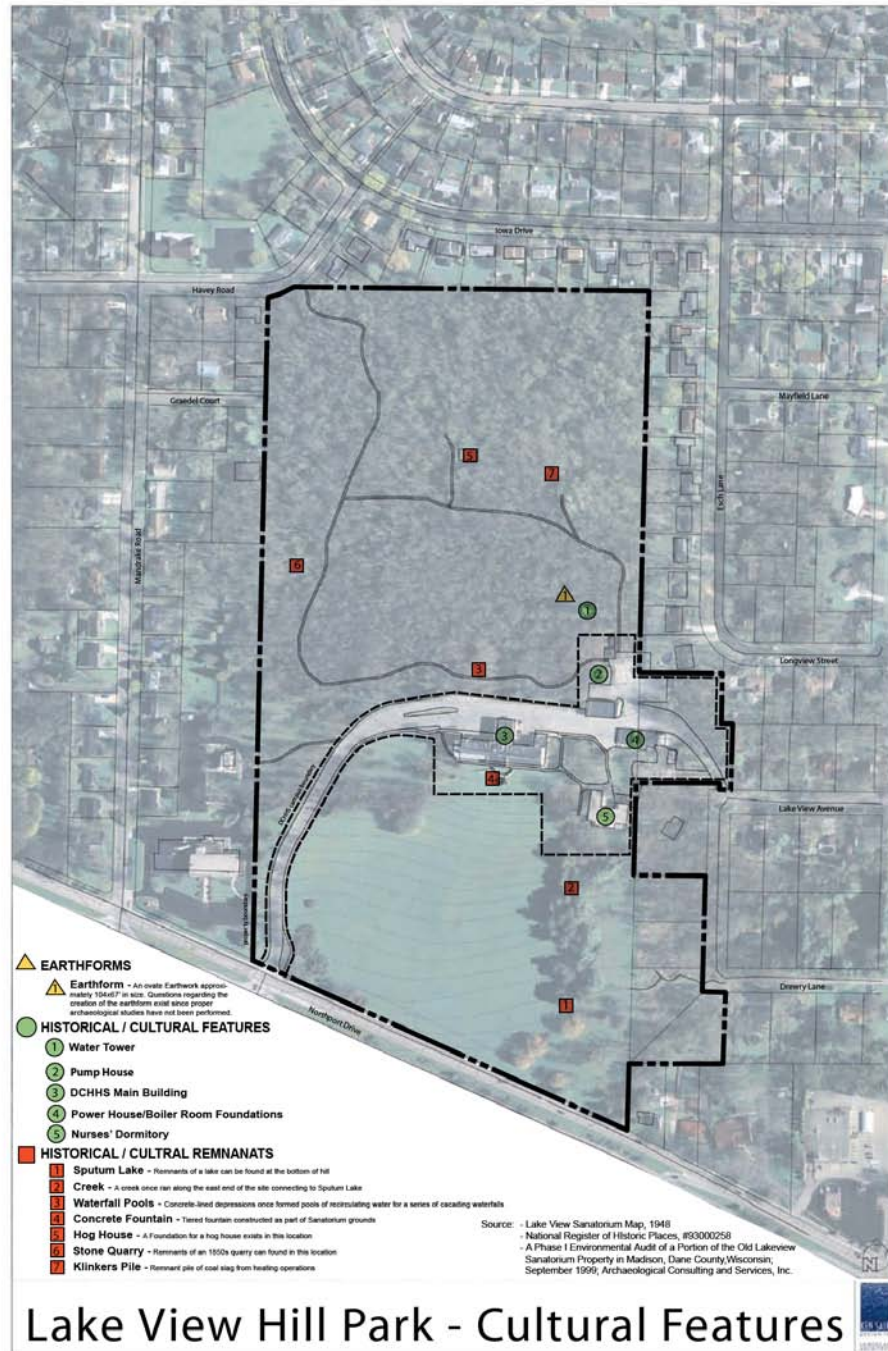
As a part of the Lakeview Reservoir reconstruction project, the water tower and the well house building are the only two features with historical significance that will be affected by construction activities.

(1) Historical, archaeological and geological features inventory, Lake View Hill County Park, Madison, WI 2008

Figure 2
Lake View Hill park - Cultural Features

Lake View Hill Park Master Plan

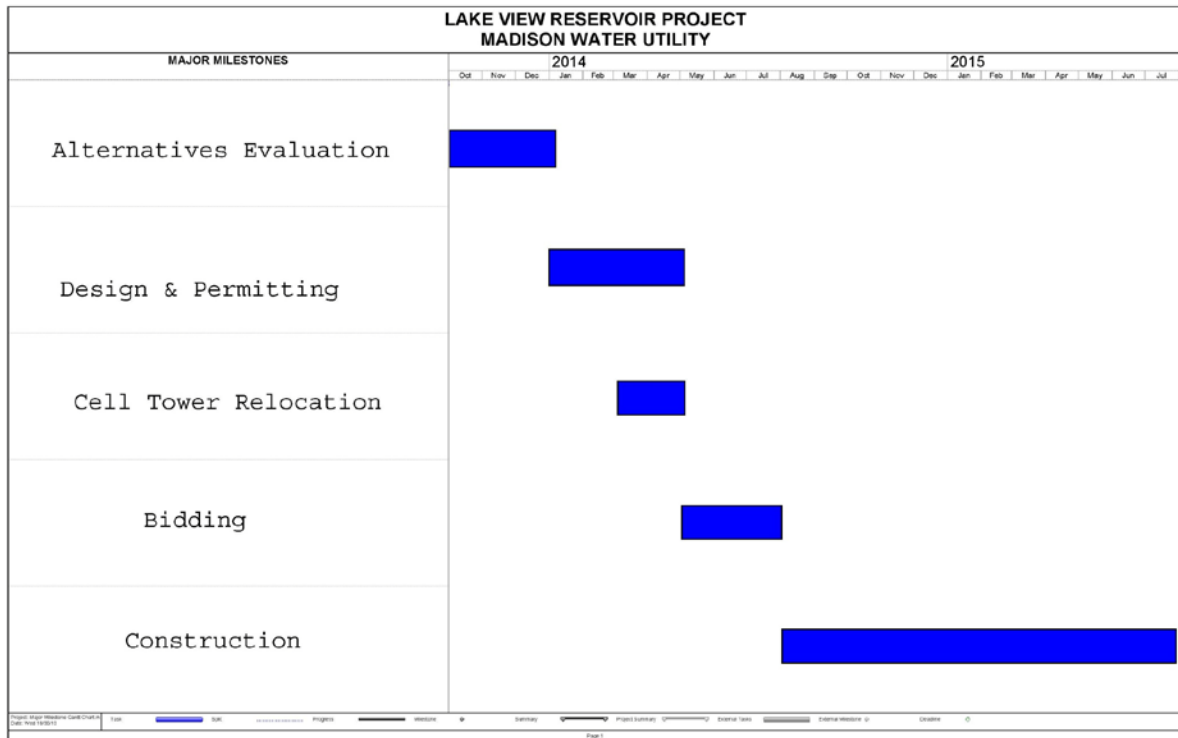
2009



5. PROJECT SCHEDULE

The Lakeview Reservoir Reconstruction project consists of three primary phases: Preliminary Design, Final Design, Bidding and Construction. Throughout all phases of the project, communication between all involved regulatory agencies, the MWU, SEH, subconsultants, and contractors is crucial to avoid delays and to ensure timely completion of the project. The timeline for the project is depicted in Figure 3.

Figure 3
Lake View Reservoir Reconstruction Schedule



5.1 Preliminary Design

The preliminary, or conceptual, design phase involves the development of site layouts, piping, and alternative evaluations for the MWU's review and approval. During this initial stage, the public will be introduced to the project. The scope and purpose of the project will be presented through a series of public meetings, after which feedback will be gathered and evaluated.

Site planning will be developed during this phase of the project, including surveying, geotechnical investigation, utility identification and coordination, identification of environmentally sensitive areas, storm drainage system design, and landscape design.

The configuration of the reservoir structure(s) will be developed with the assistance of reservoir fabrication and construction companies. The design will take into consideration the telecom communications equipment that will be installed on the structure. Design concepts will be presented to the public and CAP through a series of meetings to gain feedback. Design of the facility will focus on effective water storage and the minimization of any nuisances to the surrounding neighborhood.

A defined project schedule will be developed that includes all phases of the project. Continuous maintenance and updates to the schedule will be completed, and communication with the MWU and regulatory agencies regarding any issues or delays that may arise will be essential. Estimated project costs will be determined and updated to reflect any changes or delays.

5.2 Final Design

Once approval of the preliminary design occurs, the final design phase will begin. This stage involves the preparation of final design documents, including the site plan, reservoir configuration, landscape, site utilities, mechanical and piping, security and monitoring, and SCADA system. All drawings and project specifications are to be created to ensure competitive bidding. Coordination and cooperation with the City Planning Department is necessary to remedy issues and ensure that all requirements related to the project are met.

The final design of the reservoir structure will follow the MWU's requirements for telecommunications equipment, including the cell carriers and the City Radio Equipment. The design requirements will be provided to the existing cell carriers and City Radio system.

Timely updates to project cost estimates will be communicated to the MWU, and all efforts will be made to evaluate cost saving measures. The project schedule, including design, bidding, and construction, will be updated regularly throughout the final design phase, and all delays will be reported promptly. Review times required by all local, state, and federal regulatory entities will be included in the schedule. Monthly progress reports will be completed and submitted to the MWU with attention to detail.

A project of this magnitude requires the completion of a thorough and detailed Quality Assurance/Quality Control Plan (QA/QC) by SEH and all major subconsultants involved with the project. The QA/QC will include schedule monitoring and compliance, internal and external project reviews, communications, meetings, standards, and cost review and control.

5.3 Bidding and Construction

The final phase of the project includes bidding and construction. The Lakeview Reservoir Reconstruction project will be competitively bid through the City of Madison's Board of Public Works. SEH will provide all necessary resources to assist the MWU with the bidding process, including gathering of information, preparation of bidding and Contract documents, coordination with the Board of Public Works, answering questions from perspective bidders, attendance and participation in a pre-bid meeting, completion of Contract Addenda, and cost control of construction costs.

Coordination with the cell carriers and the MWU will be provided to relocate the cell equipment and City Radio antennas to their appropriate locations on the newly constructed reservoir.

Construction administration will include review and processing of shop drawings, operation and maintenance manuals, requests for information, requests for change, change orders, test results, and monthly pay requests. Schedule and contract compliance activities and the attendance of regular construction meetings will also be an important aspect of the construction phase. Inspection services will be provided by SEH to ensure that the project is completed on schedule and following the project contract documents. Final inspection, punch list items, training, and Project Closeout, and startup and commissioning activities will be completed with the assistance and guidance of the MWU.

6. ALTERNATIVES ANALYSIS

The overall objective of the Lakeview reservoir reconstruction is to remedy system deficiencies within Pressure Zones 5 and 6E. The following criteria have been determined to satisfy the issues that the two pressure zones currently face:

- Pressure Zone 5
 - Storage capacity of 300,000 gallons.
 - Overflow elevation of 1140.
 - Ability to be filled via Lakeview Booster station.
- Pressure Zone 6E
 - Storage capacity of 1,000,000 gallons.
 - Overflow elevation of 1080.
 - Ability to be filled via gravity from Zone 6E.

In addition to the design criteria outlined above, the MWU requires the following of the new infrastructure:

- Accommodation of up to four (4) independent cell carriers
- Accommodate the City Radio equipment.
- Integration into the Utility's PLC based SCADA system.
- Provide a finished product that is functional and durable, requires minimal maintenance, and is aesthetically pleasing.

For all alternatives considered, a primary connection will be made from the new reservoir structure to the existing water main in Northport Drive via a 16-inch pipe. In the future, a secondary 16-inch connection could be added that follows Lake View Avenue east to North Sherman Avenue.

Three primary alternatives have been identified that address the design criteria set forth for the reconstruction of the Lakeview reservoir, including the construction of a single, two-zone reservoir for Zones 5 and 6E, the construction of a reservoir for Zone 6E and the upgrade of the existing Lakeview Booster station to supplement Zone 5, and the construction of two separate reservoirs for each of Zones 5 and 6E.

6.1 Two Zone Reservoir

The two zone reservoir concept consists of two separate tanks contained within a single tower structure that will provide water to both Pressure Zones 5 and 6. The upper tank would serve Zone 5 and have a capacity of 300,000 gallons, and the lower tank would supply an additional 1,000,000 gallons to Zone 6E. The inner diameter of the base would be approximately 52 feet, and the upper portion of the tank would have a diameter of approximately 59 feet. The total height of the dual reservoir structure would reach approximately 140 feet. The tank could be constructed of steel or a combination of steel and concrete.

Several different configuration options have been discussed with the public and the MWU. These options include a hydropillar-like upper reservoir with a standpipe base, as well as a legged steel tower similar to the existing reservoir that will be constructed over a standpipe base. If the two zone reservoir alternative is selected, the final configuration will be determined with input from the public and after an evaluation of costs. Figures 4 and 5 depict the two configurations, respectively.

6.2 Zone 6E Reservoir and Booster Station

A second alternative involves the construction of a single tower to serve Pressure Zone 6E in combination with the use of the existing Lakeview Booster station to increase pressures in Zone 5. Under this scenario, the total height of the elevated storage structure would be much lower, which may cause issues with the communications entities that utilize the existing tower. The elevated tank could be constructed out of steel or concrete.

The existing booster station would also require a full rebuild, including new larger capacity pumps, piping modifications, and controls. Emergency power would be required for the station, and the total footprint of the building may need to be increased to accommodate the new equipment.

6.3 Zone 6E Reservoir and Zone 5 Reservoir

The final alternative evaluated involves the construction of separate elevated reservoir structures for each of Zones 5 and 6E. The height of the reservoir that provides water to Zone 5 would reach a height that is more acceptable for the communications equipment that will be relocated from the existing Lakeview Reservoir. The Zone 5 spheroid would be constructed out of steel, and the Zone 6E reservoir could be constructed out of steel or concrete.

The county site does not have enough room for two separate tank structures. For the two tank structures option, additional lots will need to be purchased. This option includes the cost of an additional 1 acre lot and 20 feet of additional tower height due to a lower ground elevation at these available lots.

7. PROJECT AND LIFE CYCLE COSTS

7.1 Project Budget and Available Funding Sources

The MWU has budgeted \$3,100,000 for the design and construction of the Lakeview Reservoir project, including all aspects of preliminary and final design and construction.

7.2 Life Cycle Costs

The estimated total capital costs associated with the three alternatives are depicted in Table 1. The costs include the budgetary equipment costs provided by vendors, structure costs, costs associated with upgrades to the site and any existing facilities to accommodate the reconstruction project, and engineering and contingency.

Table 1
Estimated Project Capital Costs for Lakeview Reservoir Reconstruction Alternatives

Alternative Description	Estimated Capital Costs
Two Zone Reservoir	
Steel Upper and Lower Structures	\$4,500,000
Steel Upper and Concrete Lower Structures	\$3,500,000
Zone 6E Reservoir and Booster Station	\$2,700,000
Zone 6E Reservoir and Zone 5 Reservoir	\$3,200,000

The annual operation and maintenance (O&M) costs were calculated for the three alternatives to compare the life cycle costs. O&M costs were calculated for the proposed infrastructure and do not include existing infrastructure (water distribution system, staff salaries, etc.), which would be incurred by the MWU regardless of the selected alternative.

O&M costs for Alternative 1 include the costs associated with painting the two zone hydropillar structure every 20 years and the cost to inspect the tower every 5 years. O&M costs for Alternative 2 include the costs associated with painting the 300,000 gallon spheroid every 20 years and the cost to inspect the tower every 5 years, as well as the additional labor, maintenance, and operation costs associated with the improvements to the Lakeview Pump Station. O&M costs for Alternative 3 include the costs associated with painting each of the 300,000 gallon spheroid and 1,000,000 gallon tanks every 20 years and the cost to inspect the towers every 5 years. Table 2 depicts results of the life cycle analysis of each alternative. A detailed analysis of the life cycle costs for each alternative is included in Appendix C. Table 3 depicts the estimated capital costs for each alternative, as well as the combined capital costs and present worth of maintenance costs.

Table 2
50-Year Life Cycle Costs for Maintaining Water Tanks

Alternative Description	Maintenance Costs	Present Worth
Two Zone Reservoir	\$7,829,900	\$2,975,250
Zone 6E Reservoir and Booster Station	\$9,636,000	\$3,722,950
Zone 6E Reservoir and Zone 5 Reservoir	\$9,504,800	\$3,596,470

Table 3
Combined 50-Year Life Cycle Present Worth for Maintaining Water Tanks & Capital Costs

Alternative Description	Capital Costs*	Combined Present Worth & Capital Costs
Two Zone Reservoir	\$3,500,000	\$6,475,250
Zone 6E Reservoir and Booster Station	\$2,700,000	\$6,422,950
Zone 6E Reservoir and Zone 5 Reservoir	\$3,200,000	\$6,796,470

*Capital Costs Include 20% Engineering, Legal, and Contingency.

8. EVALUATION SUMMARY AND RECOMMENDATIONS

This section presents an evaluation of each of the following items for each of the alternatives previously discussed:

- Economic Considerations
- Impact to Environment and Public
- Reliability

8.1 Economic Considerations

The total costs for each of the alternatives, including 50-year life cycle and initial capital investments, must be considered when determining which of the three alternatives considered for the Lakeview Reservoir reconstruction project.

Inherently, a water tower uses very little energy. For Alternatives 1 and 3, energy use will be limited to lights on the structure(s). No additional energy will be required to fill the structure(s) because water flows into the storage tank from system pressure. Whether it is a two tank structure or two separate structures, the energy usage would be identical. If Alternative 2 is utilized, a small amount of extra energy will be expended to pump water to Zone 5. The booster pumps will run continuously to provide acceptable pressures. The efficiency of a pump that runs continuously will not be quite as efficient as a pump that runs intermittently, even with the use of a variable frequency drive.

8.2 Impact to Environment and Public

Each alternative triggers environmental concerns, including the total area impacted by construction, the final footprint of the newly constructed structure(s), the impact that the construction activities and structure will have on the surrounding environment, the disturbance of any existing historical features within the construction footprint, and the impact that the project will have on the neighborhood and park surrounding the site.

Alternative 1 offers the smallest final footprint due to the construction of a single, elevated tower structure that will provide water to both Zones 5 and 6E. Alternative 2 will require the construction of a standpipe structure to serve Zone 6E, as well as construction activities to improve the existing Lakeview Booster Station. The greatest footprint will result from Alternative 3, in which two water tower structures will be constructed.

8.3 Reliability

A critical element to consider is the reliability of the alternative selected, or the ability of the improved structure(s) and constituents to eliminate deficiencies within the water system and to provide uninterrupted service to Zone 5 and Zone 6E customers during normal and emergency situations.

Alternatives 1 and 3 can be rated high on the reliability scale since they both utilize gravity flow from elevated towers to provide water. Alternative 2 requires the use of the Lakeview Booster Station pumps will provide service to Zone 5, which will require a larger amount of energy and the construction of a backup generator to provide power to the station during a power outage. Mechanical or electrical failures that could take the booster station offline are possible with this alternative. As a rule of thumb, elevated storage is the most reliable type of storage.

8.4 Evaluation Matrix

An evaluation matrix is presented below for Alternatives 1 through 3. The matrix ranks each alternative based upon economic considerations, footprint, and reliability.

Lakeview Reservoir Decision Matrix (Scale 1 – 3: 1 = Least Desirable, 3 = Most Desirable)			
Alternative	Two Zone Reservoir	Zone 6E Reservoir + Booster Station Upgrade	Zone 5 Reservoir + Zone 6E Reservoir
Economic Considerations	3	3	2
Footprint	3	2	1
Reliability	3	2	3
Totals	9	7	6



Most Desirable Alternative

8.5 Summary Statement

During the conceptual design process many stake holders, water tank manufacturers and the general public were engaged. Two CAP meetings were held. The first meeting took place on September 2013 which introduced the Utilities need for the project, background and history of the tank. Input was solicited and concepts were developed. A second CAP meeting was held on October 30, 2013 where three tank concepts were developed (1. two zone reservoir, 2. reservoir & booster station, 3. two reservoirs), reviewed and comments were taken. Concepts were further developed and life cycle costs analysis was generated for each concept and an alternatives analysis was completed. All of this information was prepared and displayed at a public informational meeting that was held on January 15, 2014. Comments were mixed as the two examples show below:

“First of all, thank you for all the efforts put forth on this project. I’m grateful every aspect seems to be getting in depth attention. Please give consideration to:

- *Choosing a tower that is not unique. The 2-zone one seems best.*
“Two reservoir design with open space is a great design concept. It harks back to the existing tower’s look and also could incorporate some design elements from the Lakeview Sanatorium arches, etc.
- *A neutral color (sandstone, even silver) would be much better than sky blue.*

The water utility design team has reviewed all of the comments from the public meetings in conjunction with completing a comprehensive technical engineering review of the alternatives. Our design team recommends that Alternative 1, the Two Zone Reservoir, be selected for final design based upon economic considerations, environmental and public impact, and reliability, this alternative ranks higher than the other alternatives, as depicted in the evaluation matrix.

Two reservoir design considerations were considered for the recommended alternative. The first concept is a traditional hydropillar-like design combining two tanks into one structure as shown in Figure 4. This traditional hydropillar like reservoir has been constructed within the steel industry but is not common among the industry. In our discussion with multiple water tank manufactures, this style of water tank can be built out of steel or pre-stressed concrete. Advantages and disadvantages of this tank concept include:

Advantages

- Multiple single source tank manufactures are interested and will increase competition.
- Structural integrity and warranty is held by one manufacturer.
- This style can be easily maintained based on material type selected.

Disadvantages

- Non historic looking structure based on public comments to keep the historic look.
- Capital costs are higher than the legged steel tower over a stand pipe base.

The second concept is a more historical and unique looking legged steel tower over a stand pipe base and is shown in Figure 5. This historic concept has not been completed within the industry to our knowledge. Our review of this style of structure has concluded that the capital costs may appear to be less expensive but further review has reviled the complexity of these two different tank manufacturers from competing industries may not offer the Utility the reliability of tank warranty or longevity. This concept also raises uncertainties of maintaining each structure separately, monitoring the future deficiencies with respect to each other while adding to the utilities accountability.

Advantages

- Historic looking structure based on public comments
- Capital costs are lower than the hydropillar like reservoir.

Disadvantages

- The warranty of these separate tanks may be jeopardized by future deficiencies with respect to each other.
- Not easily maintained because each tank is separated from each other.
- Uncertain maintenance costs based on individual structure types.

Based on the information included in this technical report our design team recommends that the Utility move forward with the design of the first concept (two zone reservoir alternative) a more traditional hydropillar-like design combining two tanks into one structure as shown in Figure 4.

During the design process the water utility design team will move forward with a performance based specification and design plans based on the steel industry water tank construction methods and the pre-stressed concrete water tank construction methods to meet the requirements of this technical memo's design considerations. The performance

based plans and specifications will consist of pre-qualified contractors providing a minimum of 15 years in business with similar performance based water tank construction of similar size and materials completed within the last 5 years. Contractors must also build and erect the tank based on AWWA standards, the approved utility final design concepts and the State of Wisconsin Prevailing Wage Rates. Base bids would require the tank manufacturer to choose their preferred material type, steel or pre-stressed concrete that will meet or exceed performance specifications. Evaluation of the bids, under the direction of the Utility's attorney, would take into consideration warranty, and life cycle cost analysis methods similar to those provided within this report.

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Figure 2 – Lake View Hill Park Master Plan - Cultural Features - Page 6 within Memo

Figure 3 – Lake View Reservoir Reconstruction Schedule - Page 7 within Memo

Figure 4 – Hydropillar-Like Upper Reservoir with Standpipe Base - Attached

Figure 5 – Legged Steel Tower Over Standpipe Base - Attached

Figure 4
Two Zone Reservoir Concept
Hydropillar-Like Upper Reservoir with Standpipe Base

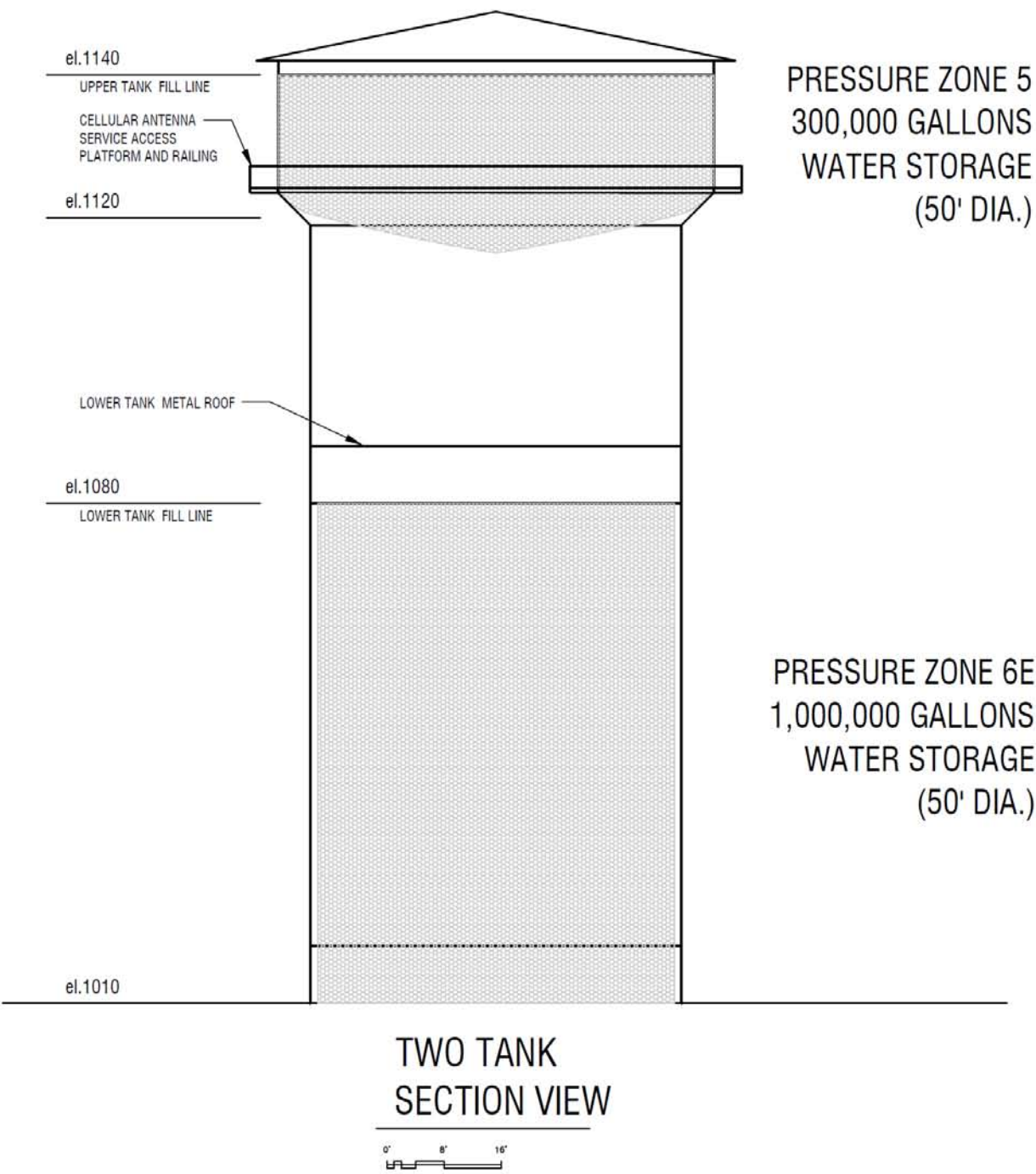
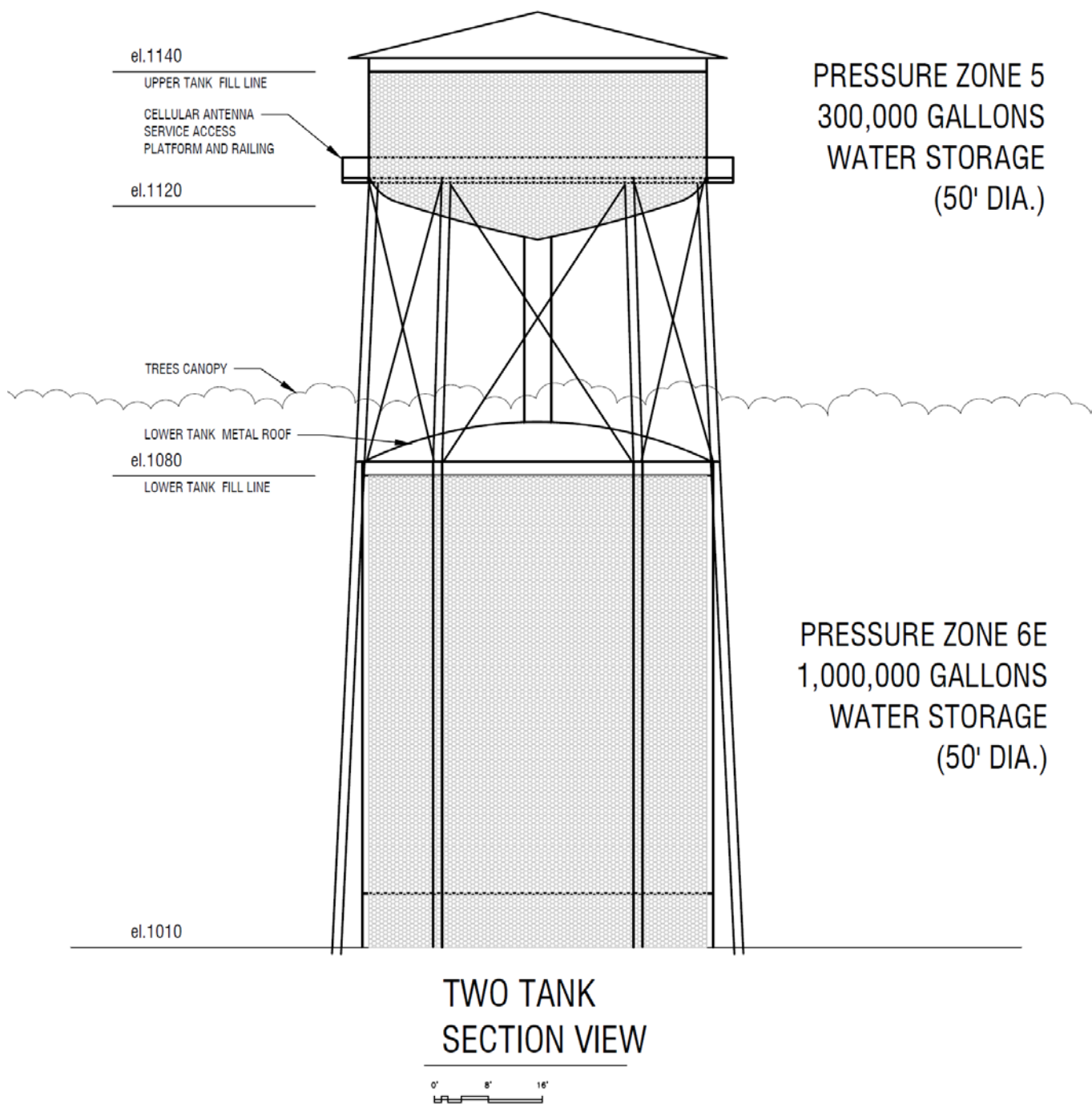
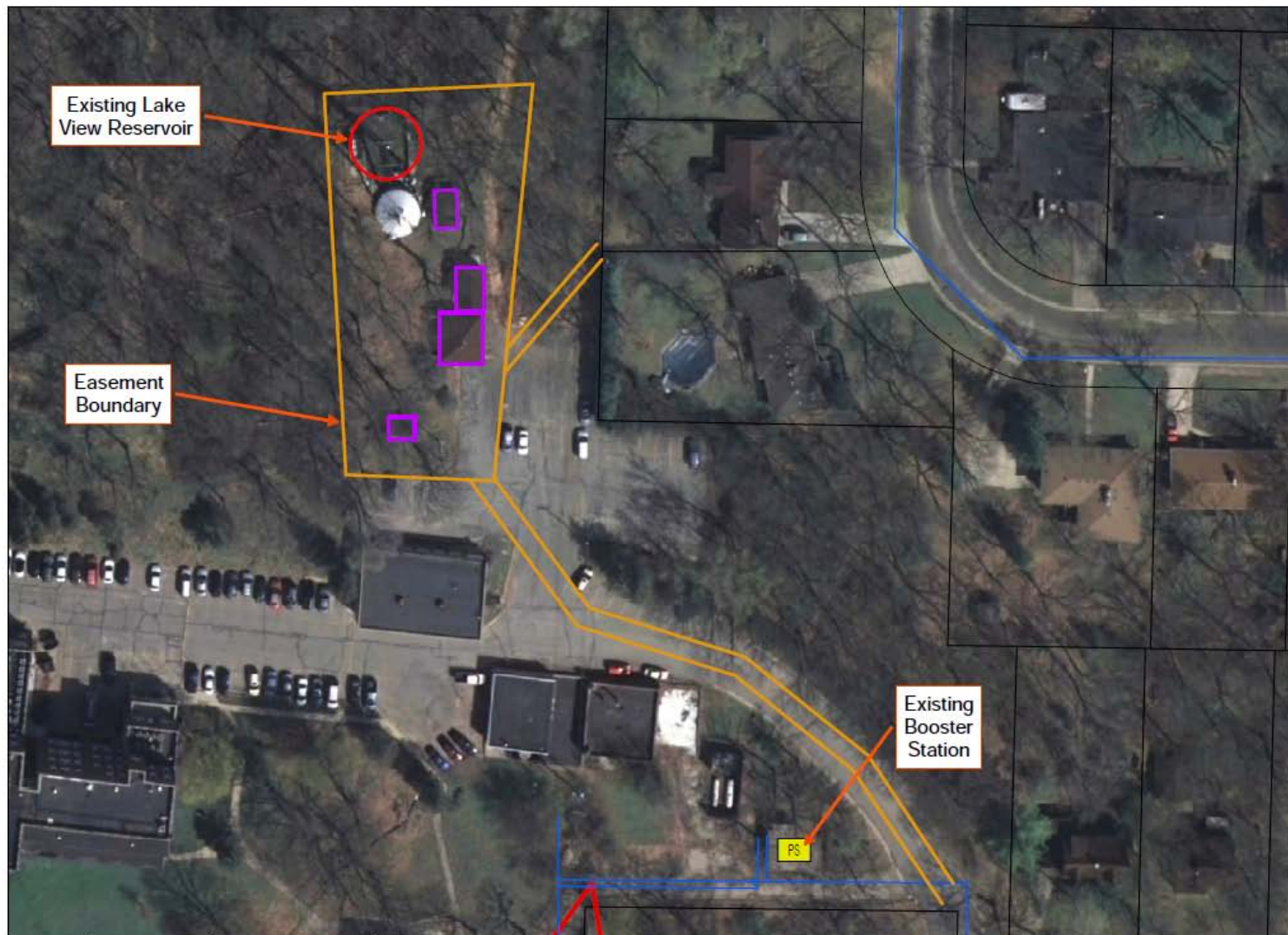


Figure 5
Two Zone Reservoir Concept
Legged Steel Tower Over Standpipe Base



Appendix A

Project Location Map



Legend

- Existing Structures
- Easement Boundaries
- Existing Reservoir Base
- PS Pumping Station
- Water Mains
- Pressure Zone 5
- Parcels



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WATTS: 800-325-2055
www.sehinc.com



Project Number
MADWU 126154

10/30/13

Madison Water Utility

Madison, Wisconsin

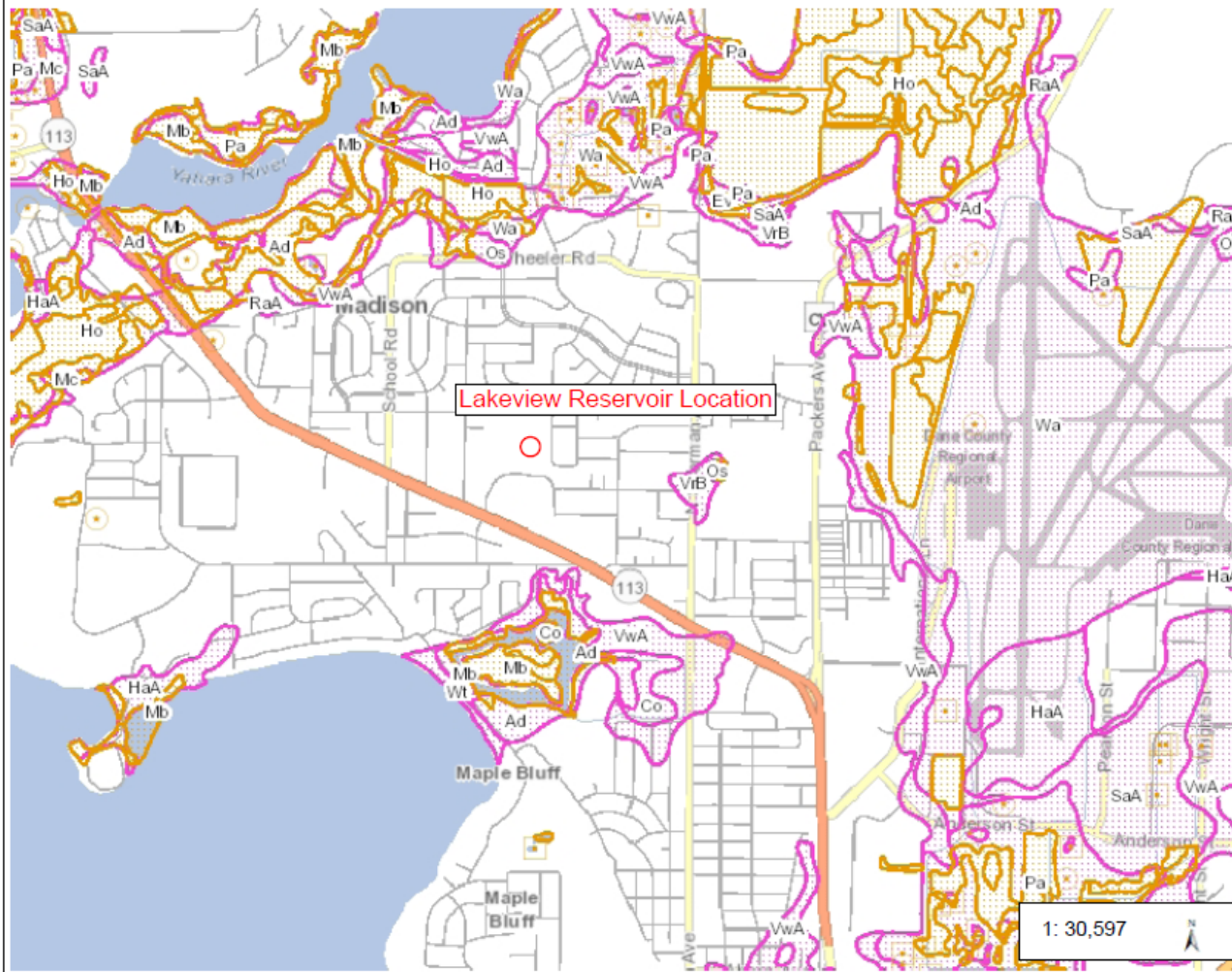
Existing
Plan View

Appendix B

DNR Wetlands and Surface Waters



DNR Surface Water Data Viewer Map



Legend

Wetland Class Points

- Dammed pond
- Excavated pond
- Filled excavated pond
- Filled/draind wetland
- Wetland too small to delineate

Filled Points

Wetland Class Areas

- Wetland
- Upland

Filled Areas

- USDA Wetspots
- Wetland Indicators
- Rivers and Streams
- Open Water

1: 30,597

1.0 0 0.48 1.0 Miles

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Notes

Lakeview Reservoir Wetland & Surface Waters

Appendix C

Tank Life Cycle Costs

Tank Life Cycle Analysis Worksheet

50-year Analysis

Madison Water Utility - Madison, Wisconsin

December 31, 2013

Assumed Maintenance Schedule:

Wash and Overcoat Years 10, 30, 50

Complete Reconditioning Years 20, 40

Inspection every 5 years

Alternative 1 - Two Zone Reservoir (300,000 Gallon Upper + 1,000,000 Gallon Lower)

300,000 Gallon Steel Upper

Outside Surface Area = 10,400 S.F.

Interior (wet) = 6,800 S.F.

Interior (dry) = 4,500 S.F.

1,000,000 Gallon Concrete Lower

Outside Surface Area = 17,600

Interior Surface Area = 18,460

cost is currently based on all steel

Steel Between Tanks

Outside Surface Area = 6,300

Inside Surface Area (Dry) = 6,300

Year	Cost per S.F. (complete paint, wet)	Cost per S.F. (complete paint, exterior) ³	Cost per S.F. (complete paint, dry interior)	Cost per S.F. (exterior wash & overcoat) ³	Cost per S.F. (interior wash & touch up)	Cost per S.F. (dry interior touch up)	Inspection	Total ^{1,2}	Inflation Rate	Future Value	Interest Rate
5							\$ 6,000.00	\$ 6,000.00	3.0%	\$ 6,955.64	3.0%
10				\$ 8.50	\$ 2.00	\$ 4.50	\$ 6,000.00	\$ 396,670.00	3.0%	\$ 533,091.31	3.0%
15							\$ 6,000.00	\$ 6,000.00	3.0%	\$ 9,347.80	3.0%
20	\$ 12.00	\$ 15.00					\$ 6,000.00	\$ 823,620.00	3.0%	\$ 1,487,549.34	3.0%
25							\$ 6,000.00	\$ 6,000.00	3.0%	\$ 12,562.67	3.0%
30				\$ 8.50	\$ 2.00	\$ 4.50	\$ 6,000.00	\$ 396,670.00	3.0%	\$ 962,822.20	3.0%
35							\$ 6,000.00	\$ 6,000.00	3.0%	\$ 16,883.17	3.0%
40	\$ 12.00	\$ 15.00	\$ 10.00				\$ 6,000.00	\$ 931,620.00	3.0%	\$ 3,038,979.65	3.0%
45							\$ 6,000.00	\$ 6,000.00	3.0%	\$ 22,689.58	3.0%
50				\$ 8.50	\$ 2.00	\$ 4.50	\$ 6,000.00	\$ 396,670.00	3.0%	\$ 1,738,964.00	3.0%
								\$ 2,975,250.00		\$ 7,829,845.36	

¹Not included are engineering when the tank is recoated.

²Includes containment, mobilization, and site restoration.

³Assumes all exterior painting happens concurrently (one containment system).

Tank Life Cycle Analysis Worksheet
50-year Analysis

Madison Water Utility - Madison, Wisconsin
December 31, 2013

Assumed Maintenance Schedule:
Wash and Overcoat Years 10, 30, 50
Complete Reconditioning Years 20, 40
Inspection every 5 years

Alternative 2 - 1,000,000 Gallon Standpipe + Booster Station Upgrade

1,000,000 Gallon Standpipe

Outside Surface Area = 13,600 S.F.
Interior Surface Area = 15,700 S.F.

Extended Standpipe for Antenna Support

Outside Surface Area = 9,500 S.F.
Interior Surface Area = 9,500 S.F.

Year	Cost per S.F. (complete paint, wet)	Cost per S.F. (complete paint, exterior)	Cost per S.F. (complete paint, dry interior)	Cost per S.F. (exterior wash & overcoat)	Cost per S.F. (interior wash & touch up)	Cost per S.F. (dry interior touch up)	Inspection	Total ^{1,2}	Inflation Rate	Future Value	Interest Rate
5							\$ 6,000.00	\$ 6,000.00	3.0%	\$ 6,055.64	3.0%
10				\$ 13.00	\$ 2.00	\$ 4.50	\$ 6,000.00	\$ 380,450.00	3.0%	\$ 511,292.99	3.0%
15							\$ 6,000.00	\$ 6,000.00	3.0%	\$ 9,347.80	3.0%
20	\$ 12.00	\$ 19.00					\$ 6,000.00	\$ 633,300.00	3.0%	\$ 1,143,810.24	3.0%
25							\$ 6,000.00	\$ 6,000.00	3.0%	\$ 12,562.67	3.0%
30				\$ 13.00	\$ 2.00	\$ 4.50	\$ 6,000.00	\$ 380,450.00	3.0%	\$ 923,452.01	3.0%
35							\$ 6,000.00	\$ 6,000.00	3.0%	\$ 16,883.17	3.0%
40	\$ 12.00	\$ 19.00	\$ 10.00				\$ 6,000.00	\$ 728,300.00	3.0%	\$ 2,375,742.12	3.0%
45							\$ 6,000.00	\$ 6,000.00	3.0%	\$ 22,689.58	3.0%
50				\$ 13.00	\$ 2.00	\$ 4.50	\$ 6,000.00	\$ 380,450.00	3.0%	\$ 1,667,857.04	3.0%
								\$ 2,532,950.00		\$ 6,690,593.27	

¹Not included are engineering when the tank is recoated.

²Includes containment, mobilization, and site restoration.

Pump Station

Year	Pump Maintenance	Energy Consumption	Building Maintenance	Emergency Generator Maintenance	Electrical System Maintenance			Total	Inflation Rate	Future Value	Interest Rate
5	\$ -	\$ 5,000.00	\$ 50,000.00	\$ 50,000.00	\$ 6,000.00			\$ 111,000.00	3.0%	\$ 128,679.42	3.0%
10	\$ 16,000.00	\$ 5,000.00	\$ 50,000.00	\$ 50,000.00	\$ 6,000.00			\$ 127,000.00	3.0%	\$ 170,677.38	3.0%
15	\$ -	\$ 5,000.00	\$ 50,000.00	\$ 50,000.00	\$ 6,000.00			\$ 111,000.00	3.0%	\$ 172,934.38	3.0%
20	\$ 16,000.00	\$ 5,000.00	\$ 50,000.00	\$ 50,000.00	\$ 6,000.00			\$ 127,000.00	3.0%	\$ 229,376.13	3.0%
25	\$ -	\$ 5,000.00	\$ 50,000.00	\$ 50,000.00	\$ 6,000.00			\$ 111,000.00	3.0%	\$ 232,409.35	3.0%
30	\$ 16,000.00	\$ 5,000.00	\$ 50,000.00	\$ 50,000.00	\$ 6,000.00			\$ 127,000.00	3.0%	\$ 308,262.33	3.0%
35	\$ -	\$ 5,000.00	\$ 50,000.00	\$ 50,000.00	\$ 6,000.00			\$ 111,000.00	3.0%	\$ 312,338.73	3.0%
40	\$ 16,000.00	\$ 5,000.00	\$ 50,000.00	\$ 50,000.00	\$ 6,000.00			\$ 127,000.00	3.0%	\$ 414,278.80	3.0%
45	\$ -	\$ 5,000.00	\$ 50,000.00	\$ 50,000.00	\$ 6,000.00			\$ 111,000.00	3.0%	\$ 419,757.14	3.0%
50	\$ 16,000.00	\$ 5,000.00	\$ 50,000.00	\$ 50,000.00	\$ 6,000.00			\$ 127,000.00	3.0%	\$ 556,756.06	3.0%
								\$ 1,190,000.00		\$ 2,945,489.73	

Total for Tank and Booster Station \$ 3,722,950.00

\$ 9,636,063.00

Tank Life Cycle Analysis Worksheet
50-year Analysis

Madison Water Utility - Madison, Wisconsin

December 31, 2013

Assumed Maintenance Schedule:

Wash and Overcoat Years 10, 30, 50

Complete Reconditioning Years 20, 40

Inspection every 5 years

Alternative 3 - 300,000 Gallon Steel Spheroid + 1,000,000 Gallon Steel Standpipe

300,000 Gallon Spheroid

Outside Surface Area =

9,510 S.F.

Interior (wet) =

6,360 S.F.

Interior (dry) =

4,700 S.F.

1,000,000 Gallon Steel Standpipe

Outside Surface Area =

13,600

Interior Surface Area =

15,700

Extended Standpipe for Antennae

Outside Surface Area =

Interior Surface Area =

Year	Cost per S.F. (complete paint, wet)	Cost per S.F. (complete paint, exterior)	Cost per S.F. (complete paint, dry interior)	Cost per S.F. (exterior wash & overcoat)	Cost per S.F. (interior wash & touch up)	Cost per S.F. (dry interior touch up)	Inspection	Total ^{1,2}	Rate	Future Value	Interest Rate
5							\$ 9,000.00	\$ 9,000.00	3.0%	\$ 10,433.47	3.0%
10				\$ 13.00	\$ 2.00	\$ 4.50	\$ 9,000.00	\$ 540,950.00	3.0%	\$ 726,991.57	3.0%
15							\$ 9,000.00	\$ 9,000.00	3.0%	\$ 14,021.71	3.0%
20	\$ 12.00	\$ 19.00					\$ 9,000.00	\$ 893,310.00	3.0%	\$ 1,613,417.23	3.0%
25							\$ 9,000.00	\$ 9,000.00	3.0%	\$ 18,844.00	3.0%
30				\$ 13.00	\$ 2.00	\$ 4.50	\$ 9,000.00	\$ 540,950.00	3.0%	\$ 1,313,027.63	3.0%
35							\$ 9,000.00	\$ 9,000.00	3.0%	\$ 25,324.76	3.0%
40	\$ 12.00	\$ 19.00	\$ 10.00				\$ 9,000.00	\$ 1,035,310.00	3.0%	\$ 3,377,220.35	3.0%
45							\$ 9,000.00	\$ 9,000.00	3.0%	\$ 34,034.36	3.0%
50				\$ 13.00	\$ 2.00	\$ 4.50	\$ 9,000.00	\$ 540,950.00	3.0%	\$ 2,371,473.98	3.0%
								\$ 3,596,470.00		\$ 9,504,789.03	

¹Not included are engineering when the tank is recoated.

²Includes containment, mobilization, and site restoration.